Spring 2008

An Ordovician Global Reference Section Recently Selected in Oklahoma

Daniel Goldman
University of Dayton, dgoldman1@udayton.edu

Stephen A. Leslie
James Madison University

Stig M. Bergström
Ohio State University - Main Campus

Jaak Nõlvak
Tallinn University of Technology

Seth A. Young
Indiana University - Bloomington

See next page for additional authors

An Ordovician Global Reference Section Recently Selected in Oklahoma

Daniel Goldman
Department of Geology, University of Dayton, Dayton, Ohio 45469

Stephen A. Leslie
Department of Geology and Environmental Science, James Madison University, MSC 6903 Harrisonburg, VA 22807

Stig M. Bergström
Division of Geological Sciences, School of Earth Sciences, The Ohio State University, Columbus, Ohio 43210

Jaak Nõlvak
Institute of Geology, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia

Seth A. Young
Department of Geological Sciences, Indiana University, Bloomington, Indiana 47405-1405

Stanley C. Finney
Department of Geological Sciences, California State University at Long Beach, Long Beach, California 90840

Ordovician fossil faunas are characterized by a marked biogeographic differentiation that results in a minimal similarity between most North American faunas and those of major Ordovician areas elsewhere in the world. This provincial distribution of most fossils has led to establishment of different schemes of fossil-based regional stages in, for instance, North America, Baltoscandia, China, and the British Isles. Because these chrono-stratigraphic units have been largely based on shelly fossils with distributions restricted to a particular region, it has been impossible in most cases to establish a precise international correlation of these regional stages. Furthermore, some general terms, such as the "Middle Ordovician," have a vastly different stratigraphic scope in different parts of the world causing confusion among stratigraphers and non-stratigraphers alike. Indeed, in view of the fact that many of today's geology studies are of more than regional nature, there has been an urgent need for an international chrono-stratigraphic classification.

This need was realized by the International Commission on Stratigraphy and its numerous subcommissions in the 1970s. Since that time, hundreds of stratigra-

phers and other geologists have been involved in a multinational effort to develop a new, firmly defined, global chronostratigraphic classification of the Phanerozoic and the Proterozoic. The goal of this work has been to define stages and series that have the potential to be used globally because they are defined in terms of fossils that are as widely distributed as possible. In the case of the Ordovician, the fossils used are graptolites and conodonts. In practice, the base of a global stage is defined as the level of first appearance of a particular species in a particular stratigraphic section, which is referred to as Global Stratotype Section and Point (GSSP). The GSSP serves as the international reference standard for the base of that particular global stage. Its top is defined as the base of the next younger global stage at its GSSP. The time-consuming work of finding the best biostratigraphic level for the base of a stage and the best section in the world for that level is handled by the International Subcommissions and their Working Groups. Commonly, the selection of a GSSP has required 10 years or more of fieldwork around the world, numerous discussion meetings, and careful evaluations of candidate sections before a final vote by the Subcommission members. If their decision and the formal GSSP proposal are approved by the International Commission on Stratigraphy, this Commission will ratify the stage as a global chronostratigraphic unit.

In the case of the Ordovician, the

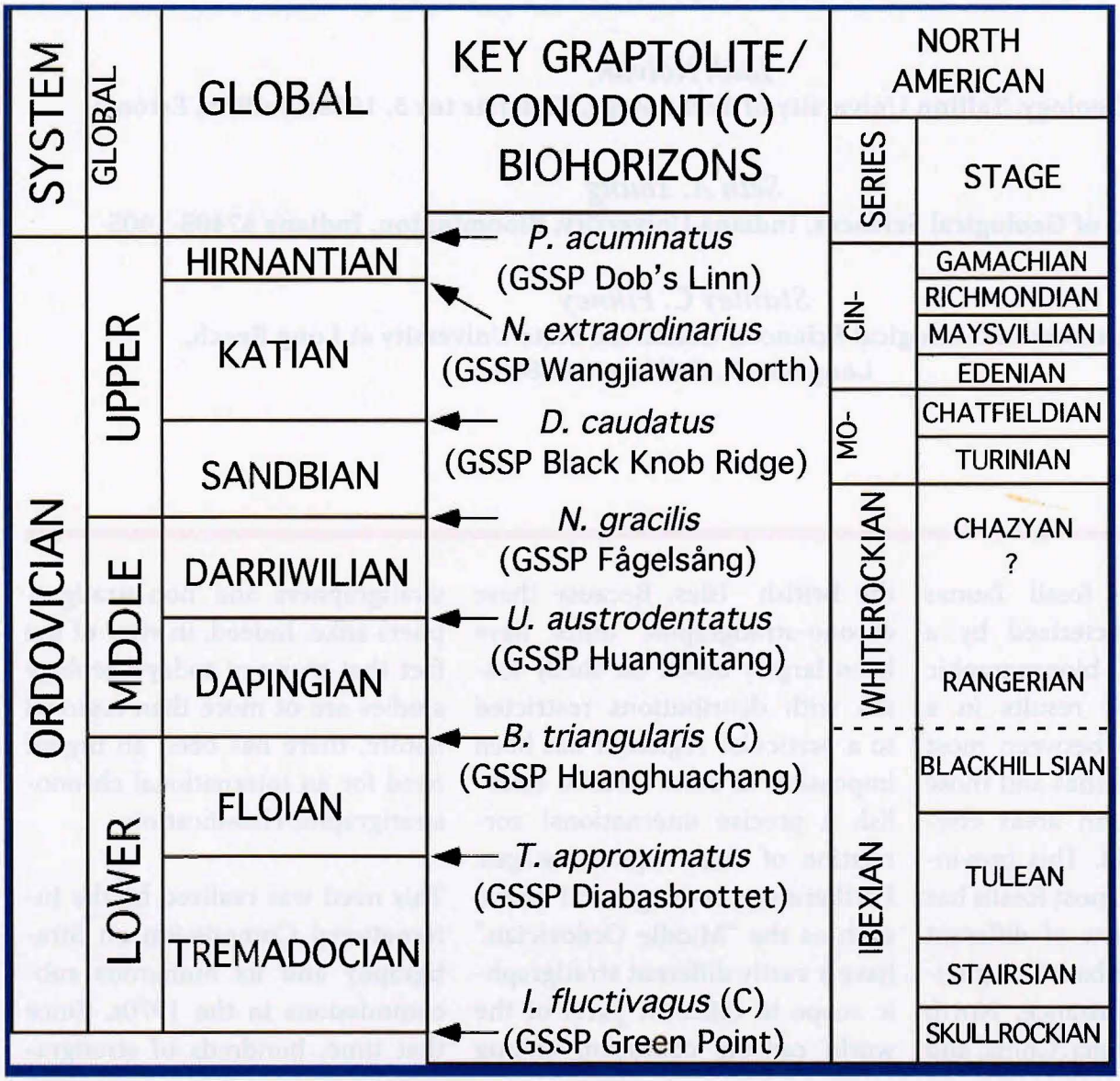

Figure 1. Global chronostratigraphic classification of the Ordovician System, GSSP localities and index fossil species, and comparison with the regional North American standard series and stage classification. Because the base of several of the North American chronostratigraphic units have never been precisely defined by diagnostic fossils, their proposed correlation to global units is approximate. *[Note: CIN- = Cincinnatian; MO- = Mohawkian.]*

Ordovician Subcommission adopted in 1995 a subdivision of the system into three series, the Lower, Middle, and Upper Series. Further Subcommission work, which has been chronicled by Webby (1998) and Finney (2005), led to the subdivision of the system into seven stages (Bergström et al., 2006). It is appropriate to stress that this new global chronostratigraphic classification does not in any way exclude the use of more or less well-known regional stage terms when this is advantageous based on the local geology and the composition of the local faunas. That is, the two stage schemes, although different, should be complimentary to each other.

The purpose of this note is to direct attention to the fact that **one of the recently ratified GSSP sites is located in Oklahoma.** Three of the others are in China, two in Sweden, and one in eastern Canada. **The Oklahoma GSSP is the only Ordovician or Silurian one in the USA, and hence an important and unique section not only for this state.**

This global reference section is situated on the western slope of Black Knob Ridge, about 5 km north of Atoka, Atoka County (Fig. 2). For a detailed description of this outcrop, see Goldman et al. (2006, 2007). After several years of worldwide investigations, a formal vote in 2005 by the members of the International Subcommission on Ordovician Stratigraphy resulted in the decision that the base of the global Middle Stage of the Upper Ordovician should be the level of the first appearance of the distinctive graptolite *Diplacanthograptus caudatus* (Fig. 3). In a separate vote, the Black Knob Ridge succession was favored over another candidate GSSP, namely an outcrop at Hartfell Spa in the southern Uplands of Scotland. The establishment of this GSSP was formally ratified by the International Commission on Stratigraphy in 2006. In the same year, **the Commission approved that the new stage should be named the Katian Stage** (Bergström et al., 2006). The name is derived from Katy Lake (now drained) that is (or was) located just southwest of the Black Knob Ridge GSSP.

The base of the Katian Global Stage is well exposed on Black Knob Ridge in the lower part of the hill slope about 4 m above the base of the Bigfork Chert (Bergström et al., 2007, Goldman et al., 2006, 2007). The index graptolite is relatively common in the extensive exposure

Figure 2. View of the Black Knob Ridge GSSP section. Looking north. The arrow marks the position of the base of the global Katian Stage.

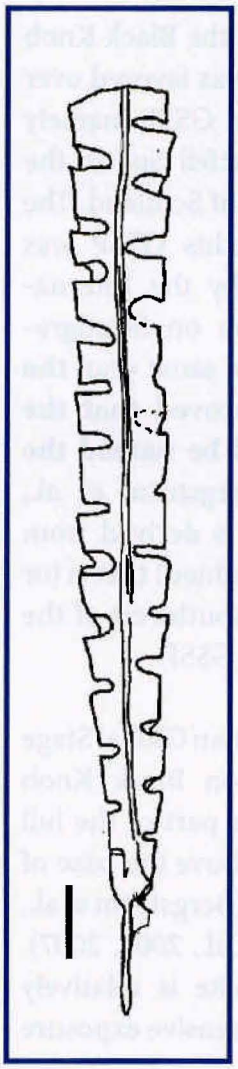

Figure 3. Camera lucida drawing of the stratigraphically important and globally distributed graptolite *Diplacanthograptus caudatus* (Lapworth), the stratigraphic appearance of which marks the base of the global Katian Stage. Scale bar is 1 mm. The illustrated specimen is from the Bigfork Chert at Black Knob Ridge (illustration modified from Goldman and Wright, 2003, Fig. 1).

of the lower Bigfork Chert at this locality as are conodonts on dark shale bedding plane surfaces and chitinozoans. This, in combination with the presence of K-bentonite beds (Bergström et al., 2008) and rocks suitable for carbon isotope geochemistry (Goldman et al., 2006, 2007), makes this exposure an excellent GSSP.

We expect that formal dedication ceremonies of this GSSP will take place in the near future. We feel that the State of Oklahoma can take pride in having this unique international reference section and hope that suitable arrangements will be made to preserve it for its future use by geologists in Oklahoma and elsewhere in the world. It should be noted that local authorities at some other Ordovician global reference sections have fully recognized their scientific importance. This is particularly the case in China where elaborate 'geoparks' with monuments, multi-lingual explanation signs, and other markers designating these reference localities as important natural heritage sites have been established (Chen et al., 2006).

Acknowledgements

This work was supported by ACS/PRF grant# 43907-B8 to Dan Goldman and Steve Leslie, and Estonian Science Foundation grant #SF0140020s08 and ETF 7640 to Jaak Nõlvak.

References cited

Bergström, S. M.; Finney, S. C., Chen Xu, Goldman, D.; and Leslie, S. A., 2006, Three new Ordovician global stage names: Lethaia, v. 39, p. 287-288.

Bergström, S. M.; Leslie, S. A.; Huff, W. D.; and Sell, B. K., 2008, Ordovician K-bentonites discovered in Oklahoma; Oklahoma Geology Notes v. 68, no. 1 & 2, p. 4-14.

Chen Xu; Zhang Yuan-Dong; Bergström, S. M.; and Xu Hong-Gen, 2006, Upper Darriwilian graptolite and conodont zonation in the global stratotype section of the Darriwilian Stage (Ordovician) at Huangnitang, Changshan, Zhejiang, China: Palaeoworld, v. 15, p. 150-170.

Finney, S., 2005, Global Series and Stages for the Ordovician System: A progress report: Geologica Acta, v. 3, p. 309-316.

Goldman, D.; Leslie, S. A.; Nõlvak. J.; and Young, S., 2006, The Black Knob Ridge section, southeastern Oklahoma: A possible Global Stratotype-section and Point (GSSP) for the base of the Middle Stage of the Upper Ordovician Series. Ratified proposal. Website of the International Commission on Stratigraphy (http:www:/stratigraphy.org/BKR.pdf), 44-pp.

Goldman, D.; Leslie, S. A.; Nõlvak, J.; Young, S.; Bergström, S.M.; and Huff, W.D. 2007, The Global Stratotype Section and Point (GSSP) for the base of the Katian Stage of the Upper Ordovician Series at Black Knob Ridge, Southeastern Oklahoma, USA. : Episodes, v. 30, p. 258-270.

Goldman, D.; and Wright, S. J., 2003, A revision of *"Climacograptus" caudatus* (Lapworth) based on isolated three-dimensional material from the Viola Springs Formation of central Oklahoma, USA: INSUGEO, Serie Correlación Geológica, v. 18, P. 33-37.

Webby, B. D., 1998, Steps towards a global standard for Ordovician stratigraphy: Newsletters in Stratigraphy, v. 36, p. 1-33.